rainfall; the weather; the appearance of leaves and flowers of plants; the appearance or disappearance of birds and insects; observations with regard to fish and other animals; and miscellaneous observations. But Gilbert White enriched his "Calendar" with much other matter. There are not only numerous disquisitions on points of natural history, but notes of events of public interest and of personal or domestic concern. These are written on interleaves, or such spaces as may happen to be available. It is proposed to arrange for the publication of the diary in the manner of the original in every substantial particular. There will be no editorial notes, except in elucidation of a few points of real obscurity. It will fill two large quartos of about 700 pages each, and Messrs. Constable and Co. are to be the publishers.

IN the current number of the *Bulletin de la Classe des Sciences* of the Royal Belgian Academy is a paper by M. Henry, on some new reactions of formaldehyde. Phosphorus pentachloride and pentabromide give methylene dichloride and dibromide respectively, the latter in so good a yield as to be an advantageous method of preparation. Formaldehyde also reacts readily with acetyl chloride to give chlormethyl acetate, acetyl bromide giving the corresponding bromine compound. The yields are better than those given by the interaction of the halogen and methyl acetate.

THE same number of the *Bulletin* contains an exhaustive study, by M. Gillot, of the hydrolysis of raffinose by *Penicillium glaucum*. In solutions containing a mineral acid the mould is able to secrete a zymase capable of inverting raffinose, and this ferment is still produced, although more slowly, when the solution is neutral. In alkaline solutions the germination of the spores is retarded, the solution losing its alkalinity as the development of the mould proceeded, finally becoming acid. The zymase from a pure culture of the *Penicillium* was isolated, and raffinose inverted by its aid.

THE additions to the Zoological Society's Gardens during the past week include a —— Baboon (*Cynocephalus*, sp. inc.) from Zanzibar, a Suricate (*Suricata tetradactyla*) from South Africa, a Common Boa (*Boa constrictor*), an Anaconda (*Eunectes murinus*) from South America, a Pin-tailed Sand-Grouse (*Pterocles alchata*), South European, deposited; a Panolia Deer (*Cervus eldi*, ♀) from Burmah, five Common Wigeon (*Mareca penelope*), three Pochards (*Fuligula ferina*), three Tufted Ducks (*Fuligula cristata*), four Goldeneyes (*Clangula glaucion*), European; a Common Boa (*Boa constrictor*) from South America, purchased; a Barbary Wild Sheep (*Ovis tragelaphus*), born in the Gardens.

OUR ASTRONOMICAL COLUMN.

ASTRONOMICAL OCCURRENCES IN MAY.

May 1. 8h. 58m. to 9h. 48m. ι Tauri (mag. 4·7) occulted by the moon.

1–6. Epoch of the Aquarid meteoric shower (radiant 338°–2°).

2. 5h. Venus in conjunction with moon. Venus 4° 55′ N.

5. 11h. 48m. to 12h 42m. A¹ Cancri (mag. 5·6) occulted by the moon.

6. 11h. 1m. to 11h. 51m. ω Leonis (mag. 5·6) occulted by the moon.

7. 10h. 43m. to 11h. 49m. 19 Sextantis (mag. 6·0) occulted by the moon.

15. Venus. Illuminated portion of disc, 0·402; Mars, 0·975.

22. 10h. 8·7m. Jupiter's Sat. IV. in conjunction N. of the planet.

27. 7h. Jupiter in opposition to the sun.

28. Total eclipse of the sun, partially visible at Greenwich.

Times of Occurrence and Magnitude for places in the British Isles.

Place.	Eclipse begins. h. m.	Middle of eclipse. h. m.	Eclipse Ends. h. m.	Magnitude.
Greenwich ...	2 47·0 ...	3 54·9 ...	4 57·5 ...	0·681
Cambridge ...	2 46·7 ...	3 53·9 ...	4 56·0 ...	0·664
Oxford	2 45·3 ...	3 53·6 ...	4 56·7 ...	0·683
Liverpool ...	2 42·1 ...	3 49·9 ...	4 52·9 ...	0·655
Edinburgh ...	2 40·8 ...	3 46·1 ...	4 47·4 ...	0·599
Dublin	2 37·9 ...	3 47·4 ...	4 52·0 ...	0·676

This is the largest solar eclipse visible in England since that of 1870 December 22, when about eight-tenths of the sun were obscured.

31. 18h. Venus at her greatest brilliancy.

PHOTOGRAPHS OF THE AURORA SPECTRUM.—M. Paulsen describes in *Comptes rendus*, cxxx. pp. 655–656, 1900, his successful attempts to obtain a photographic record of the spectrum of the aurora borealis. His station was in Iceland, where he states the displays were very vivid during the period December 31, 1899, to January 25, 1900, and photographs were obtained with two spectrographs, one having a quartz train for recording especially the ultra-violet, the second with glass components. In all twenty-two lines have been recorded, of which sixteen are new. Their wave-lengths have been provisionally determined by means of comparison photographs of the spectra of air and metals, and are as follows:—

Strong lines: 337, 358, 391, 420.
Faint lines: 353, 371, 376, 381, 393, 397, 402, 406, 412, 417, 422, 432, 436, 443, 449, 456, 463, 470.

The four strong lines were obtained from even feeble streamers, but for the others it was necessary to keep the spectroscope in the brightest regions. Besides the lines given, several others can be seen between λλ 357 and 250, but are too feeble for reduction.

NEW VARIABLE STAR IN TAURUS.—Dr. Anderson, of Edinburgh, announces in the *Astronomische Nachrichten* (Bd. 152, No. 3634), that he has detected variability in the star having the following position for 1855:—

R.A. = 5h. 44·1m.
Decl. = + 15° 45′.

This star is not in the B.D., and some years ago he found it about magnitude 9·25, while on 1899 November 8 it was invisible in a 3-inch refractor, which plainly showed a neighbouring star of 11 mag. On 1900 March 26 it was about 9·7 mag.

NEW VARIABLE IN CASSIOPEIA.—In the *Astronomische Nachrichten* (No. 3634), Dr. Anderson also announces the variability of a star in Cassiopeia, whose position for 1855 is

R.A. = 23h. 48·4m.
Decl. = + 52° 55′.

On 1900 February 10 the star was 9·6 mag.; but on March 17 and 25 it was less than 10·5 mag.

FORMULA FOR ATMOSPHERIC REFRACTION.—In the *Comptes rendus* (vol. cxxx. pp. 1060–1061, 1900), M. L. Cruls gives a simple formula for calculating the astronomical atmospheric refraction, which is found to give results very closely in agreement with those calculated from Laplace's formula.

The equation is

$$R = (60'' \tan z - 1'' \tan^2 z)\left(0{\cdot}00138B - 0{\cdot}00001\frac{Bt}{2}\right),$$

in which R is the refraction, z the zenith distance of the object, B the barometric pressure, and t the temperature in degrees Centigrade at the time of observation.

A table of comparisons is given, showing that the difference in the refraction, as obtained from the above formula and that of Laplace, is only 0″·2 at 10° zenith distance, the error gradually increasing as the horizon is approached; but even at 70° zenith distance the two formulæ give results differing only by 1″·6 of arc.

DETERMINATION OF AXIS AND COMPRESSION OF NEPTUNE.—The *Astronomical Journal*, No. 479 (vol. xx. pp. 181–185), contains an article by Prof. S. J. Brown, of the U.S. Naval Observatory, on the determination of the position of Neptune's axis, and the degree of its polar compression from an investigation of the perturbations of the orbit of its satellite. Eighteen determinations of the orbit of the satellite to this planet have been made during the period 1848–1898, but, owing to the position of the planet and the plane of the orbit, many of the earlier observations are very discordant, and it was only on publication of the results obtained with the 26-inch at Washington that the certainty of change in the position of the orbit plane was manifest (*Washington Observations*, 1873, 1881, Appendix i.). Marth first drew attention to the changes as being too great for systematic errors, but attempted no explanation as to their cause (*Monthly Notices*, vol. xlvi. p. 504), and finally Tisserand used his data to show that the phenomenon could be explained by the assumption of a moderate polar compression of the planet (*Comptes rendus*, vol. cvii. p. 804). In calculating the perturbation Prof. Brown neglects the action of the sun and other planets, as the chief effect is undoubtedly due to the equatorial protuberance on Neptune itself. He therefore analytically obtains the elements of the satellite's orbit with respect to the invariable plane of the planet's equator, along which the node of the former moves with a uniform *retrograde* motion, the *inclination* of the two planes remaining constant.

The variations of these elements at the various epochs then furnish data for computing the annual motion of the node of the orbit of the satellite on the equator of Neptune as seen from the earth. The elements finally obtained indicate a period of revolution of the node in 531 years. At the epoch 1900·0 the position angle of Neptune's polar axis will be 158°·4, and the plane of its equator will make an angle of $-21°·6$ to the line of sight.

Taking the value 1″·10 as the most probable radius of the planet from recent observations, and the mean distance of the satellite as 16″·308, the flattening of Neptune is found to be about 1/43. This would indicate a low mean density for the planet, the value given being 1·83 times that of water.

THE RELATIONS BETWEEN ELECTRICITY AND ENGINEERING.[1]

THE nineteenth century is distinguished in our profession chiefly by the knowledge we have obtained of the constitution of *matter* and of the qualities of the materials we utilise for the service of man, of the presence and the characteristics of that medium—*the aether*—which fills all space, and of the existence, indestructibility and protean character of that great natural source of force, motion, work and power which we call —*energy*.

Electricity is only one of many forms of this energy. It is measureable in well defined and accurately-determined units. It is produced and sold, utilised and wasted. It is, therefore, something distinctly objective. It has even been defined by Act of Parliament. There are four great principles underlying the practical applications of electricity:—

(1) The establishment of a magnetic field.
(2) The establishment of an electric field.
(3) The disturbance or undulation of the æther.
(4) The work done by the generation and maintenance of electric currents in material systems.

Electricity as a science is fascinating to every one, but it is deeply fascinating to the engineer. The trustworthiness of its laws, the accuracy of its measurements, and the completeness and definiteness of the units to which its measurements are referred give him confidence in his estimates and a certainty of the performance of his preconcerted operations. It places in his hands the means of directing the energy out of sight in positions known only to himself, and of applying it with great efficiency at the exact spot desired. No magician or poet ever conceived so potent a power within the easy reach of man.

The Doing of Work.

The maintenance of an electric current through a conductor means the expenditure of work upon that conductor, and this expenditure of internal work means molecular motion. In solid conductors the result is *heat*. If the current be gradually increased, this motion is similarly increased. The result is successively incandescence, white heat, fusion and disruption.

[1] Abridged from the "James Forrest" Lecture delivered at the Institution of Civil Engineers, on April 23, by Sir William Henry Preece, K.C.B., F.R.S.

In liquid conductors the motion probably becomes revolution. The result is decomposition by the activity of the centrifugal force overcoming chemical affinity. The atoms fly away in fixed determined lines, and collect at opposite poles.

In gases the transference of electric energy in the form of sparks means dissociation. Compound gases are broken up into their component elements under the same directing influences. Work is done upon the gas as in the previous instances.

The principle of work that lies at the very root of the profession of the engineer enables all these operations to be measured in definite mechanical units, reducible to the common English standard, the *foot-pound*, but which the electrical engineer, with greater precision, refers to the scientific unit of work—the *Joule*.

The Purification of Matter.

The elements and their useful compounds are rarely, if ever, found pure. Impurities have to be sifted away. Ores, raw produce, rocks and earths have to be subjected to various processes of refining and conversion to extract from them that which is wanted. The electric current by the above operations has proved to be a powerful agent to break up crude materials into their useful and useless constituents. The electro-chemical industries of the world are very extensive.

According to Prof. Borchers, the eminent electro-metallurgist, the world manufacture of calcium carbide for the production of acetylene gas is utilising a power equal to 180,000 HP.; that of the alkalies and the combinations of chlorine for bleaching, 56,000 HP.; of aluminium, 27,000 HP.; of copper, 11,000 HP.; of carborundum, 2600 HP.; and of gold, 455 HP. Electroplating is one of the staple manufactures of Sheffield and of Birmingham. There are nearly 200 firms working at the former place, and over 100 at the latter.

The decomposing bath and the arc furnace are revolutionising many industries. Phosphorus is now being produced in England in large quantities from corundum, and aluminium from bauxite is extending in use and being reduced in price. The Post Office is using aluminium for telephone circuits. I have recommended its use on a very large scale in the interior of Africa, where transport is so costly. We can get the same conductivity as with copper with half the weight, and at a less price, and we can put up a line telegraphically ten times better than of iron for less money.

The Annihilation of Space.

The elements of Volta and the battery of Galvani—zinc, copper and a solution of sulphuric acid—gave a convenient generator of electric currents which could be directed along wires to great distances, and thus, by establishing magnetic fields, could deflect needles in such a way as to form the alphabet and so transmit words and, therefore, thought. In wires of great length, while the initial speed is that of light, it takes time for the electric waves to rise and fall, so that the number of currents which can be sent per second is limited. Between London and Liverpool the speed of speaking is virtually unlimited, but between Ireland and America it is restricted by the so-called *capacity* of the cable submerged in the ocean. This capacity absorbs energy and retards the rate of rise and fall of currents. While a thousand currents per second can be sent in the former case, only six per second are available in the latter.

Nevertheless, sitting on the shore of the Atlantic in Ireland, one can manipulate a magnetic field in Newfoundland so as to record simultaneously on paper in conventional characters slowly written words. Thus we have bridged the ocean and annihilated space.

The regulation of the ever-growing traffic on our railways and the safety of passengers is secured by similar means. The telegraph not only places the manager of the line in communication with every station upon his system, but electric signals control the motion of every train. A railway signal-box is an electrical exhibition. Every line is protected by its own electric signal. Every distant outdoor mechanical signal is repeated back. The danger signal is locked, and cannot be lowered to "line clear" until it is unlocked by the train itself or by the distant signalman. Mr. F. W. Webb is not only working the outdoor signals themselves by electrical energy, but he is moving the points and switches by the same means. So far, the experience gained at Crewe during a period of about twelve months, from the working of a signal cabin containing about sixty levers, has been such as to justify confidence and the extension of the system, and some